Evaluation of MerCAP™ for Power Plant Mercury Control

Quarterly Technical Progress Report

January 1, 2004 – March 31, 2004

Prepared by:

Carl F. Richardson

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Cooperative Agreement No: DE-FC26-03NT41993

URS Group, Inc.
9400 Amberglen Boulevard
Austin, Texas 78729

Prepared for:

William Aljoe

National Energy Technology Laboratory
U.S. Department of Energy
P.O. Box 880
Morgantown, WV 26508-0880

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ABSTRACT

This document summarizes progress on Cooperative Agreement DE-FC26-03NT41993, "Evaluation of MerCAP™ for Power Plant Mercury Control," during the time-period January 1, 2004 through March 31, 2004. The objective of this project is to demonstrate the performance of MerCAP™, a technology that uses a fixed sorbent downstream of wet and dry scrubbers for removing mercury from coal-combustion flue gas. The project is being funded by the U.S. DOE National Energy Technology Laboratory under this Cooperative Agreement. EPRI, Great River Energy, and Southern Company are project co-funders. URS Group is the prime contractor.

The general concept for MerCAP™ is to place fixed structure sorbents into a flue gas stream to adsorb mercury and then, as the sorbent surfaces become saturated, thermally regenerate the sorbent and recover the mercury. One example includes parallel gold-coated plates. Mercury forms an amalgam with the gold and is removed from the flue gas flowing past the plates. The captured mercury can be subsequently sequestered using a carbon canister or cryogenic trap during regeneration.

In this project, URS Group and its team will conduct tests at two host power plants to evaluate gold MerCAP™ performance downstream of a spray dryer-baghouse and a wet scrubber over an extended period of flue-gas exposure. The spray dryer site, identified in this proposal as Site 1, is Great River Energy's Stanton Station that burns a ND lignite coal. At this site, an array of gold-coated MerCAP™ plates will be incorporated into the outlet plenum of one compartment (6 MWe equivalent) of the Unit 10 baghouse. Site 2, the wet scrubber site, is Southern Company Services' Plant Yates that burns an Eastern bituminous coal. Gold-coated structures will be configured as a mist eliminator and configured downstream of a pilot (1 MWe equivalent) wet scrubber receiving a flue gas slipstream obtained immediately downstream of a full-scale FGD absorber. MerCAP™ will be evaluated for mercury removal during normal boiler operation for periods of six months at both sites.

The ability to repeatedly thermally regenerate exposed MerCAP™ plates is a critical component to the overall economics of the technology. Therefore, during the longer-term tests, small-scale tests will be conducted to evaluate the mercury removal effectiveness at both sites following repeated regeneration cycles. Tests will be conducted using a 40-acfm slipstream probe device ("Mini-MerCAP™ probe"). Gold-coated substrates from the same production batch used for the MerCAP™ arrays in the larger longer-term tests will be used in the Mini-MerCAP™ probe. MerCAP™ technology has been successfully tested in small-scale units installed at the proposed test sites. Results of the study will verify this performance at a larger scale and over a longer period of gas exposure and will provide data required for assessing the feasibility and costs of a full-scale MerCAP™ application.

During this period, efforts included kickoff activities and initial planning for Site 1 testing. Work on the design of the Site 1 MerCAP™ system was also started. This technical progress report provides an update on these efforts.

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INTRODUCTION

This document is the quarterly Technical Progress Report for the project "Evaluation of MerCAP™ for Power Plant Mercury Control," for the time-period January 1, 2004 through March 31, 2004. The objective of this project is to demonstrate the performance of MerCAP™, a technology that uses a fixed sorbent downstream of wet and dry scrubbers for removing mercury from coal-combustion flue gas. The project is being funded by the U.S. DOE National Energy Technology Laboratory under this Cooperative Agreement. EPRI, Great River Energy, and Southern Company are project co-funders. URS Group is the prime contractor.

The general concept for MerCAP™ is to place fixed structure sorbents into a flue gas stream to adsorb mercury and then, as the sorbent surfaces becomes saturated, thermally regenerate the sorbent and recover the mercury. One example includes parallel gold-coated plates. Mercury forms an amalgam with the gold and is removed from the flue gas flowing past the plates. The captured mercury can be subsequently sequestered using a carbon canister or cryogenic trap during regeneration. In this project, URS Group and its team will conduct tests at two host power plants to evaluate gold MerCAP™ performance downstream of a spray dryer-baghouse and wet scrubber over an extended period of flue-gas exposure. Testing at each host site will take place for a period of 6 months.

Great River Energy is providing co-funding and technical support to this project and is providing Stanton Station Unit 10 as a host site. Unit 10 fires North Dakota Lignite and is configured with a spray dryer as a dry FGD system, with a downstream baghouse for particulate control. At this site, an array of gold-coated MerCAP™ plates will be incorporated into the outlet plenum of one compartment (6 MWe equivalent) of the Unit 10 baghouse.

Southern Company is also providing co-funding and technical input to this project and its subsidiary, Georgia Power, is providing its Plant Yates as a host site for testing. Plant Yates Unit 1 fires a low-sulfur bituminous coal and is configured with a small-sized ESP for particulate control, and a downstream CT-121 Jet Bubbler Reactor (JBR) wet FGD system**.** Gold-coated structures will be configured as a mist eliminator and configured downstream of a pilot (1 MWe equivalent) wet scrubber receiving a flue gas slipstream obtained immediately downstream of a full-scale FGD absorber.

The ability to repeatedly thermally regenerate exposed MerCAP™ plates is a critical component to the overall economics of the technology. Therefore, during the longer-term tests, small-scale tests will be conducted to evaluate the mercury removal effectiveness at both sites following repeated regeneration cycles. Tests will be conducted using a 40-acfm slipstream probe device ("Mini-MerCAP™ probe"). Gold-coated substrates from the same production batch used for the MerCAP™ arrays in the larger longer-term tests will be used in the Mini-MerCAP™ probe. MerCAP™ technology has been successfully tested in small-scale units installed at the proposed test sites. Results of the proposed study will verify this performance at a larger scale and over a longer period of gas exposure and will provide data required for assessing the feasibility and costs of a full-scale MerCAP™ application.

This report describes the activities carried out for this program during the project-reporting period January 1 through March 31, 2004. The remainder of this report is divided into four sections: an Executive Summary followed by a section that describes Experimental procedures, then sections for Results and Discussion, and Conclusions.

EXECUTIVE SUMMARY

Summary of Progress

The current reporting period, January 1, 2004 through March 31, 2004, is the first full technical progress reporting period for the project. Efforts during the current period focused on tasks associated with initiating and planning the test program. Specific activities included initial planning and scheduling for Site 1, a host site survey, design of the MerCAP™ installation and instrumentation, and beginning the electroplating effort. Table 1 lists the planned and completed milestones for the first year of this project. A summary of each activity carried out during this reporting period is provided below.

Table 1. Schedule for Year 1 Milestones for this Test Program.

Milestone	Description	Baseline	Expected Completion	Actual Completion
1	Submit Hz. Subs. Plan	Q4 2003	Q1 2004	Q1 2004
2	Submit Test Plan	Q4 2003	Q1 2004	Q1 2004
3	Frame Installation/Baseline Monitoring Site 1	Q1 2004	Q2 2004	
4	Site 1 Gold Installation, Intensive Testing	Q1 2004	Q2 2004	
5	Start of Long Term Testing, Site 1	Q1 2004	Q3 2004	
6	End of Long Term Site 1, Gas Char Tests	Q3 2004	Q1 2005	
7	Site 1 Review/ Site 2 Planning Meeting	Q3 2004	Q1 2005	
8	Frame Installation/Baseline Monitoring Site 2	Q4 2004	Q1 2005	

URS and Apogee personnel attended the DOE Kick-off meeting held in Pittsburgh in November 2003. The overall project was presented and scheduling discussed.

Schedule:

Changes in the host plant operation have required a schedule change to accommodate plant operation and other DOE testing at the site. The MerCAP™ installation and demonstration has been pushed back to avoid overlap with an activated carbon injection (ACI) test series being run under a separate DOE-funded program. That ACI effort on Unit 10 at Stanton will be completed prior to any MerCAP™ components being placed in service. The current planned MerCAP™ schedule is shown in Table 2 below:

Table 2. Proposed Schedule for MerCAP™ Demonstration at Stanton 2004

MerCAP™ Installation	June-July 2004
Long-term Demonstration	Aug 2004-Jan 2005

Site Survey:

A site survey, including meeting with plant engineers about the proposed design, was conducted in early December 2003. Issues including design weight, structural support, and plant impacts were discussed. Access, power, and test equipment locations outside the test baghouse compartment were also discussed. The current design size and geometry was determined to not structurally impact the baghouse compartment. The current design is estimated to weigh less than 4000 pounds and will be distributed across several existing structural members. Primary impact on the baghouse compartment will be re-routing of compressed air lines that power the sonic cleaning system and the addition of feed-through ports to allow instrumentation and sampling of the MerCAP^{TM} array from outside the compartment.

The site survey resulted in minor dimensional modifications to the current design to simplify access and handling by personnel through the compartment access doors and between structural members. The design will not impact the plant's ability to repair or maintain the existing bags in the compartment. Based on the revised design geometry, two prototype duct sections that will support the MerCAP^{TM} substrates were fabricated to validate the design.

Design Effort:

A set of production drawings have been completed for the MerCAP^{TM} Assembly and used for a preliminary bid estimate. The frame design is still evolving but will be based on the components shown in Figure 1 below. An alternate to the ring staples that secure the leading and trailing edges that will provide a cleaner, more secure attachment of the substrate is currently being pursued.

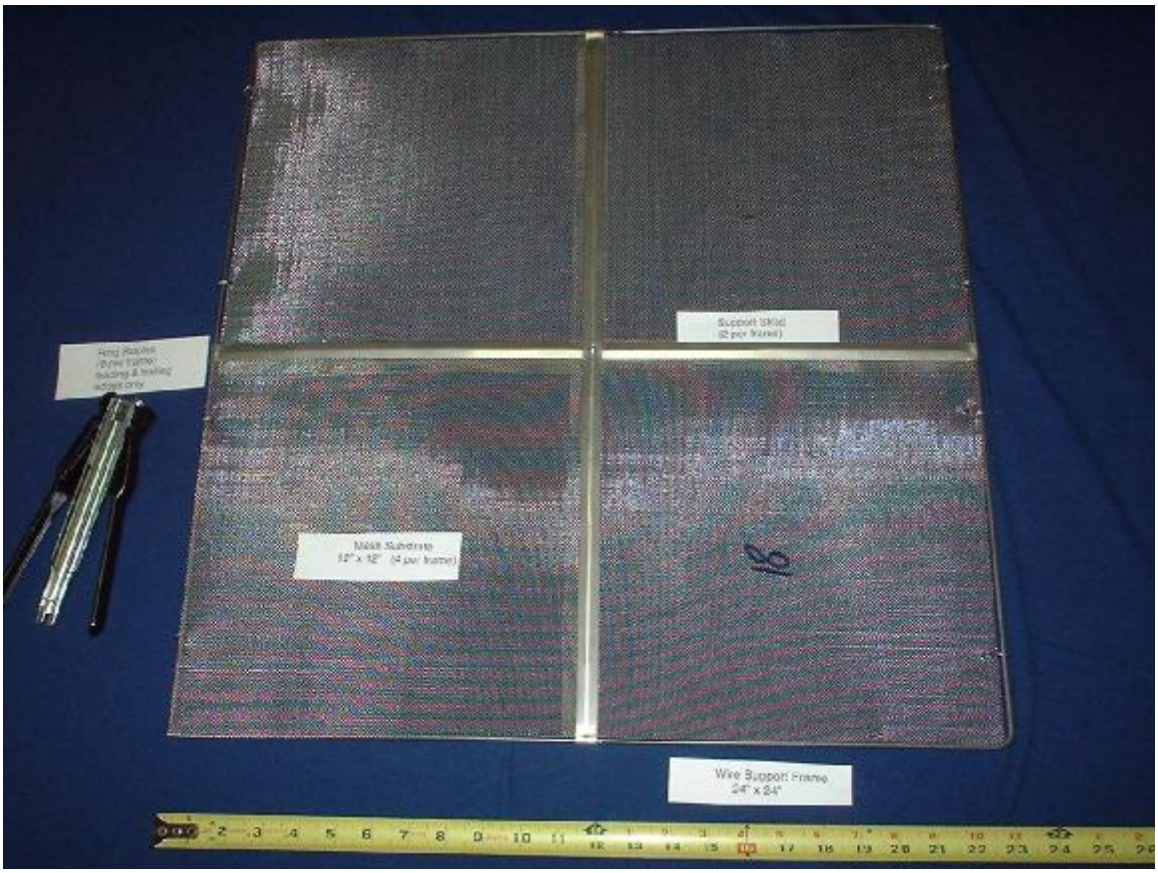

Figure 1. Prototype Wire Support Frame

The duct sections that hold the frame assemblies have been refined into a modular design that will allow rapid installation into the baghouse compartment. Four gas flow channels, each 12 feet, in length will be used to house the MerCAP^{TM} substrates supported in the wire frames. Figure 2 is a photograph of two of these prototype duct sections. A bolted flange connects each section and secures the channeled rack system that allows sliding the Wire Support Frames into place. An actual system will use 3 of these 4-foot long sections to achieve the total 12-foot length. Figure 3 shows an inlet view of a section as the gas will enter the MerCAP^{TM} unit. Only 1 frame assembly and three tracks on 1-inch centers are shown.

Figure 2. Prototype Duct Sections that House the MerCAP™ Frames

Figure 3. View of MerCAP™ Inlet

Electroplating Effort:

A sample set of substrates using the 12-inch x 12-inch geometry were gold-coated using the same techniques (baths, electroplating cathodes frames, and current densities) that will be employed to produce the production substrates. Two different coating thicknesses were run, and a quality control method was developed to document coating thickness and uniformity at several locations across the substrates. This technique uses X-ray diffraction to measure thickness at point locations, and gold concentration in the electroplating baths taken at the beginning and end of each run provide a secondary check of the total mass of gold plated on the substrates.

Instrumentation:

The design and component specification of the instrumentation system that will monitor and record the performance of the MerCAP^{TM} array is complete. The bulk of the needed components have been purchased and received and the assembly of the instrumentation system into a weatherproof enclosure has begun.

Planned Activities:

A team review of the MerCAP^{TM} design to be used at the Stanton Station will be conducted and the balance of the fabrication effort will be completed. The purchase order for electroplating of the substrates will be placed. A second meeting with the plant personnel will be scheduled to review the installation construction process and to assign responsibilities between the plant personnel, URS, Apogee, and other outside contractors.

Actual installation of components may start as early as June, but no later than July 1 in preparation for the August 2004 start-up.

Sub-Contracts

No sub-contracts were awarded during this reporting period.

Task Activity Summary

Table 3 lists the current activity status of the primary tasks for this program. The Stanton MerCAP™ testing has been delayed due to operation issues at the host site and conflicts with other DOE projects set to take place at Stanton.

Table 3. Project Activity Status.

Task Number	Description	Planned % Completion	Actual % Completion
1	Project Planning	50%	50%
2	Stanton MerCAP™ Testing	50%	15%
3	Yates MerCAP™ Testing	0%	0%
4	Economic Analysis	0%	0%
5	Project Management & Reporting	15%	15%

Problems Encountered

No technical problems were encountered during this reporting period, however there were scheduling problems including changes in Stanton operations, and conflicts with other DOE projects set to take place at Stanton. The MerCAP™ installation and demonstration has been pushed back to avoid overlap with an activated carbon injection (ACI) test series being run under a separate DOE-funded program. That ACI effort on Unit 10 at Stanton will be completed prior to any MerCAP™ components being placed in service. The MerCAP™ installation is now set to begin in June 2004 and not later than July 1, 2004 in anticipation of start-up in August.

Plans for Next Reporting Period

The next reporting period covers the time-period March 1 through June 30, 2004. The primary activities planned for this period include completion of the Stanton MerCAP™ design, fabrication and installation. Mercury measurement equipment will also be installed at the plant.

Baseline testing will be carried out at Stanton. During these periods, mercury measurements will be made to evaluate current mercury emissions under normal operation. Manual gas characterization measurements will be made to verify mercury analyzer results and determine particulate and halogen species concentrations in the flue gas. During the initial installation of the MerCAP™ system, a period of intensive mercury measurements will be made across the unit using SCEMs. These will last approximately one week, and will determine the initial performance of the MerCAP™ system.

Prospects for Future Progress

During the subsequent reporting period (June 1 through September 30, 2004), long term testing is planned for the MerCAP™ installation at Stanton. Work activities will include periodic mercury measurements across the large-scale unit, as well as mercury measurements made across the mini MerCAP™ probes with attempts at regeneration.

EXPERIMENTAL

This technical progress report covers the first reporting period for this program. Activities performed to date have been primarily associated with kicking off and planning the project. Thus, no experimental work was conducted during this reporting period.

RESULTS AND DISCUSSION

No technical results are yet available for this program.

CONCLUSION

Initial planning for this program, including a project kickoff meeting and a site visit to Stanton Station, was carried out during this project reporting period. An initial design was developed for the MerCAP™ installation, and prototypes were fabricated. The original schedule for installation and testing was delayed to accommodate operational issues at site 1 Stanton Station that included conflicts with other DOE projects performed at this site.

REFERENCES

No references.